



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁷ : H04N 9/64	A1	(11) International Publication Number: WO 00/70881 (43) International Publication Date: 23 November 2000 (23.11.00)
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(21) International Application Number: PCT/KR00/00249
(22) International Filing Date: 22 March 2000 (22.03.00)
(30) Priority Data:
60/134,550 17 May 1999 (17.05.99) US

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(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG,
BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE,
ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP,
KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA,
MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU,
SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG,
UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS,
MW; SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ,
BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE,
CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC,
NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA,
GN, GW, ML, MR, NE, SN, TD, TG).

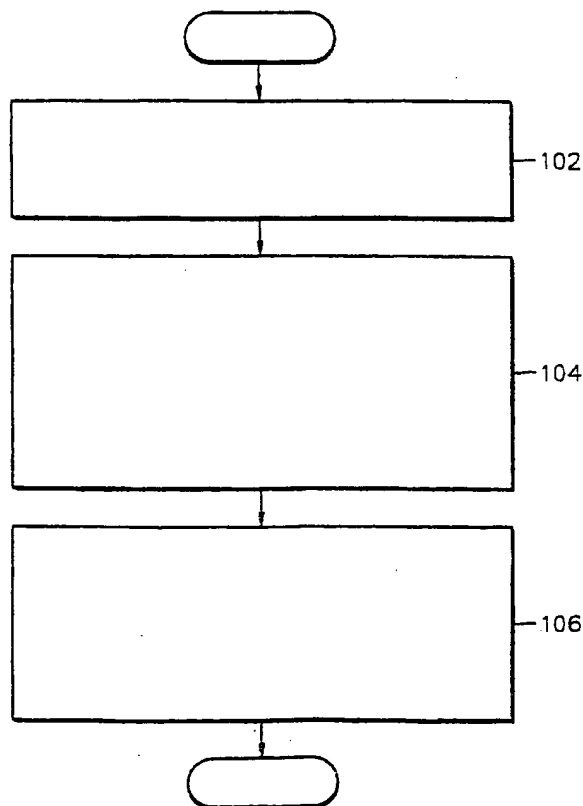
Published

With international search report.
In English translation (filed in Korean).

(54) Title: COLOR IMAGE PROCESSING METHOD

(57) Abstract

A color image processing method is provided. The color image processing method includes the step of: (a) indexing a color image by assigning representative colors of an image to a color space divided into a plurality of regions. The color image processing method may be applied to object-based image processing such as MPEG-7, and a fast search and retrieval of multimedia contents can be made.



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COLOR IMAGE PROCESSING METHOD

Technical Field

The present invention relates to a color image processing method,
5 and more particularly, to a method for indexing a color image so that
searching for a color image can be efficiently performed.

The present invention also includes a color image searching method
for searching an image corresponding to a query image in a database
indexed by the color image processing method.

10

Background Art

According to conventional color image processing methods, one
color is expressed as one vector in a three-dimensional (hereinafter
referred to as a 3-D) color space composed of three axes ranging from 0 to
15 255. Thus, each pixel in an image is expressed as one of 256x256x256
values. That is, a database must have 256x256x256 storage places so as
to store a color feature vector of the image in the database. Also, in a
matching process, searching of 256x256x256 values may have to be
performed. Thus, according to the conventional color image processing
20 methods, a large capacity database is required, and it takes much time to
search a desired image from the database.

Disclosure of the Invention

To solve the above problems, it is an object of the present invention
25 to provide a color image processing method capable of indexing a color
image and fast search and retrieval of a desired image by using a small
capacity database.

It is another object of the present invention is to provide a medium
for storing a program performing the color image processing method.

30 It is still another object of the present invention is to provide a color
image searching method for searching a desired image in the color image
indexed according to the color image processing method.

It is yet still another object of the present invention is to provide a medium for storing a program performing the color image searching method.

Accordingly, to achieve the above object, according to one aspect
5 of the present invention, there is provided a color image processing method. The color image processing method comprises the step of (a) indexing a color image by assigning representative colors of an image to a color space divided into a plurality of regions.

It is preferable that the color image processing method further
10 comprises the step of (pa-1) obtaining the representative colors of the image and their ratio.

It is also preferable that the ratio is a percentage.

Preferably, the color image processing method further comprises the
step of (b) storing a region identifier expressing the representative colors,
15 their ratio, and serial numbers of an image and a region in a database as data.

Preferably, the image is one region selected from divided regions.

Also, the color space is preferably a 3-D color space.

In order to achieve the above objects, according to another aspect
20 of the present invention, there is provided a color image processing method. The color image processing method comprises the steps of: (a-1) obtaining a feature vector F expressed as an i -th representative color c_i and as its ratio p_i when N is the number of representative colors in the divided regions of an image, and i is an integer between 1 and N : $F = \{ \{c_i, p_i\}, i = 1,$
25 $\dots, N \}$; (a-2) indexing the image by assigning the representative colors to lattice points of a color space having a lattice structure; and (a-3) storing indexed results in a database having the form of a separate table.

In order to achieve another object, there is provided a medium for
storing a program performing a color image processing method for indexing
30 an image. The media comprises the steps of: (a-1) obtaining a feature vector F expressed as an
 i -th representative color c_i and as its percentage p_i when N is the number

of representative colors in the divided regions of an image, and i is an integer between 1 and N : $F = \{ \{c_i, p_{ij}\}, i = 1, \dots, N \}$; (a-2) indexing the image by assigning the representative colors to lattice points of a 3-D color space divided into a plurality of regions; and (a-3) storing indexed results in a database having the form of a separate table.

In order to achieve still another object, according to one aspect of the present invention, there is provided a color image searching method for searching an image in the database based on a color feature of a query image. The color image searching method comprises the step of (a) performing a search based on representative colors of a query image and their ratio in the database indexed by assigning the representative colors of a database image to a color space divided into a plurality of regions.

The color space is preferably a 3-D color space.

It is preferable that the step (a) comprises the steps of: (a-1) obtaining representative colors of a given query image and their ratio; (a-2) selecting a region corresponding to the representative color obtained in the step (a-1) in a color space divided into a plurality of regions; (a-3) selecting a data group indexed into the region selected from a database; and (a-4) identifying matched data in which the difference in the ratio of the representative color of the query image is less than a predetermined threshold value in the selected data group.

It is also preferable that the step (a) further comprises the steps of: (a-5) obtaining the sum of the ratio of same regions from the identified data; and (a-6) determining the region in which the difference between the sum of the obtained ratio and the sum of the ratio to the query image is less than a predetermined threshold value as a searched image.

Preferably, the color image searching method further comprises the step of performing the steps in the color space with respect to neighboring peripheral regions in the case where there are no regions determined as the searched image.

Preferably, the query image is one region of the image divided into

a plurality of regions, and the searched image is one region of the database image divided into a plurality of regions.

In order to achieve still another object, according to another aspect of the present invention, there is provided a color image searching method for searching an image in the database based on a color feature of a query image. The color image searching method comprises the steps of: (a-1) obtaining representative colors of given query regions and their ratio; (a-2) selecting a lattice point corresponding to the representative color obtained in the step (a-1) in a 3-D color space divided into a plurality of lattices; (a-3) selecting a data group corresponding to the lattice point selected from the database in which a region identifier expressing representative colors of data images, their ratio, and serial numbers of an image and a region is stored as data; (a-4) identifying matched data in which a difference in the ratio of the representative color of the query regions is less than a predetermined threshold value in the selected data group; (a-5) obtaining the sum of the ratio of same regions from the identified data; and (a-6) determining the regions in which the difference between the sum of the obtained percentages and the sum of the ratio of the query regions is less than a predetermined threshold value as a searched image.

In order to achieve yet still another object, there is provided a medium for storing a program performing a color image searching method. The medium comprises the steps of: (a-1) obtaining representative colors of given query regions and their ratio; (a-2) selecting a lattice point corresponding to the representative color obtained in the step (a-1) in a 3-D color space divided into a plurality of lattices; (a-3) selecting a data group corresponding to the lattice point selected from the database in which a region identifier expressing representative colors of data images, their ratio, and serial numbers of an image and a region is stored as data; (a-4) identifying matched data in which the difference in the ratio of the representative color of the query regions is less than a predetermined threshold value in the selected data group; (a-5) obtaining the sum of the ratio of same regions from the identified data; and (a-6) determining the

regions in which the difference between the sum of the obtained percentages and the sum of the ratio of the query regions is less than a predetermined threshold value as a searched image.

5 Brief Description of the Drawings

The above objects and advantages of the present invention will become more apparent by describing in detail a preferred embodiment thereof with reference to the attached drawings in which:

FIG. 1 is a flowchart illustrating a color image processing method
10 according to a preferred embodiment of the present invention;

FIG. 2 illustrates one feature vector extracted from one region of an image;

FIG. 3 illustrates a 3-D color space having a lattice structure;

FIG. 4 illustrates a database having the form of a separate table
15 used for the color image processing method of FIG. 1; and

FIG. 5 is a flowchart illustrating a color image searching method according to the preferred embodiment of the present invention.

Best mode for carrying out the Invention

20 Referring to FIG. 1, which illustrates a flowchart of a color image processing method according to a preferred embodiment of the present invention, first, representative colors and their distribution are identified in the regions of an image (step 102). Here, a percentage can be used for the distribution, and the percentage can be understood as a value in which the
25 number of corresponding pixels is divided by the number of the entire pixels by corresponding representative colors and multiplied by 100.

The identified representative colors and their percentages can be expressed as a feature vector. That is, when N is the number of representative colors in the regions, and i is an integer between 1 and N ,
30 the feature vector F expressed as an i -th representative color c_i and as its percentage p_i is obtained by the following equation (step 104):

$$F = \{ \{c_i, p_i\}, i = 1, \dots, N \}.$$

Referring to FIG. 2, which illustrates one feature vector extracted from one region of an image, the feature vector F of a first region R_1 in an arbitrary image is expressed as a first representative color c_1 and its percentage p_1 , a second representative color c_2 and its percentage p_2 , and
 5 a third representative color c_3 and its percentage p_3 . Likewise, the feature vector of other regions R_2 , R_3 , and R_4 can also be expressed.

Subsequently, the image is indexed by assigning the representative colors to lattice points of a 3-D color space having a lattice structure, and indexed results
 10 are stored in a database having the form of a separate table (step 106). The indexed results include a region identifier expressing the representative colors, their ratio, and serial numbers of an image and a region.

Referring to FIG. 3, which illustrates a 3-D color space having a
 15 lattice structure, the 3-D color space composed of coordinate axes L , U , and V has a lattice structure. Each lattice has lattice points n_1 , n_2 , n_3 , n_4 , n_5 , and n_6 in its center, and colors belonging to the range of this lattice are indexed into these lattice points.

Now, an assumption is made that the first representative color c_1 is
 20 included in the lattice having a first lattice point n_1 , and the second representative color c_2 is included in the lattice having a $(k-1)^{\text{th}}$ lattice point n_{k-1} , and the third representative color c_3 is included in the lattice having a third lattice point n_3 .

Each representative color and its percentages are stored in the
 25 database having the form newly-defined in a color image processing method according to the present invention. The database is classified into the storage places in which data corresponding to the lattice points n_1 , n_2 , n_3 , \dots , n_{k-1} , and n_k are stored. This database is formed of a separate table, because the data expressing representative colors of each region and their
 30 percentages are separated and stored.

FIG. 4 illustrates a database having the form of a separate table used for the color image processing method of FIG. 1.

Now, the representative colors and their percentages are stored with a region identifier expressing each serial number of an image and a region in the places corresponding to lattice points to which the representative colors belong.

5 Then, the data expressing the first representative color c_1 and its percentage p_1 are stored in the places corresponding to the first lattice point n_1 together with the region identifier ID_1 . Also, the data expressing the second representative color c_2 and its percentage p_2 are stored in the places corresponding to the $(k-1)^{th}$ lattice point n_{k-1} . Furthermore, the third
10 representative color c_3 and its percentage p_3 are stored in the places corresponding to the third lattice point n_3 . Here, region identifiers ID_1 , ID_2 , and ID_3 only express the same region of same image. In other words, referring to the database shown in FIG. 4, the first lattice point n_1 corresponds to data ID_1 , c_1 , and p_1 , the third lattice point n_3 corresponds to
15 data ID_3 , c_3 , and p_3 , and the $(k-1)^{th}$ lattice point n_{k-1} corresponds to data ID_2 , c_2 , and p_2 .

According to the above color image processing method, an image is indexed by assigning the representative colors of the image to a color space divided into a plurality of regions. Accordingly, the database size for
20 storing an index information of an image is relatively small.

The color image indexed by the above color image processing method can efficiently search similar images to a query image, an image which a user wishes to search by the color image searching method according to the present invention.

25 Referring to FIG. 5, which illustrates a flowchart of a color image searching method according to the preferred embodiment of the present invention, first, query regions, an original image which a user wishes to search in a database are determined.

Subsequently, representative colors of the determined query regions
30 and their percentages are identified (step 502). The step 502 is same as the step 102 in the color image processing method shown in FIG. 2. Here, the percentages can be understood as values in which the number of

corresponding pixels is divided by the number of the entire pixels by corresponding representative colors and multiplied by 100.

After that, a lattice point corresponding to each representative color identified is selected (step 504). As shown in FIG. 3, a number of the
5 representative colors are included in one region having the form of a lattice, and a 3-D color space in which lattice points for distinguishing the region exist in the center of the region is assumed. That is, the identified representative colors have the regions to which the colors belong in the 3-D color space. Accordingly, the lattice points, center points of the regions,
10 can be selected.

Also, in order to eliminate false matches, it is more preferable to consider the representative colors and their distribution, that is, their percentages together. Accordingly, a data group corresponding to the selected lattice point from the database is selected (step 506), and matched
15 data in which the difference in the percentages of the representative colors of the query regions is less than a predetermined threshold value in the selected data group are identified (step 508). For example, assuming that 30% or so of one representative color of the representative colors in the query regions is included in the query regions, and the predetermined
20 threshold value is 5%, data which correspond to the same lattice point as one representative color selected from the query regions and $\pm 5\%$ of 30%, the percentage of one representative color selected from the query regions, that is, 25% to 35% data are determined as the matched data.

After that, the sum of the percentages of same regions among the
25 matched data is obtained (step 510). In other words, the data expressed as same regions by the region identifier among data determined as the matched data are sorted and the sum of the percentages with respect to the sorted data is obtained.

Subsequently, the regions in which the difference between the sum
30 of the percentages obtained in the step 510 and the sum of the percentages of the query regions is less than a predetermined threshold value are determined as searched regions (step 512). As an alternative to this, it is

possible to determine a small number of regions in which there is the least difference aligning according to the difference in the percentages as the searched regions or to determine only one region in which there is a minimum difference in the percentages as the searched region.

5 However, according to this method, for example, in the case where the representative colors of the query regions are located at an outer area in the lattice, there is a possibility that the regions having similar colors to the representative colors belong to another lattice, and then, the regions may be not searched. Accordingly, in the case where there are no regions
10 determined as the searched regions, it is more preferable to perform steps 506 through 512 with respect to peripheral lattice points of the lattice point used for performing a search before (step 514).

 According to the above-described color image processing method and color image searching method can be used for a computer program.
15 Codes and code segments constituting the program can be easily inferred by a skilled computer programmer in the art. Also, the program is stored in computer readable media, read and executed by a computer, and it can thereby realize the color image processing method. The media include magnetic media, optical media, and carrier waves.

20 As described above, according to the present invention, the color image processing method may be applied to object-based image processing, and a fast search and retrieval of multimedia contents can be made.

25 Industrial Applicability

 According to the above-described color image searching method, due to the small size of a database the search speed can be fast, and the search can be efficiently made by not classifying images unnecessarily in detail. Further, the above color image searching method may be applied
30 to object-based image processing, and a fast and efficient search and retrieval of multimedia contents can be made.

What is claimed is:

1. A color image processing method for indexing an image, comprising the step of (a) indexing a color image by assigning representative colors of an image to a color space divided into a plurality
5 of regions.
2. The color image processing method according to claim 1, further comprising the step of (pa-1) obtaining the representative colors of the image and their ratio.
- 10 3. The color image processing method according to claim 2, wherein the ratio is a percentage.
4. The color image processing method according to at least one
15 of claim 2 or claim 3, further comprising the step of (b) storing a region identifier expressing the representative colors, their ratio, and serial numbers of an image and a region in a database as data.
5. The color image processing method according to one of
20 claims 1 through 3, wherein the image is one region selected from divided regions.
6. The color image processing method according to claim 4, wherein the image is one region selected from divided regions.
- 25 7. The color image processing method according to at least one of claims 1 through 3 or claim 6, wherein the color space is a three-dimensional color space.
8. The color image processing method according to claim 4,
30 wherein the color space is a three-dimensional color space.

9. The color image processing method according to claim 5, wherein the color space is a three-dimensional color space.

10. A color image processing method for indexing an image,
5 comprising the steps of:

(a-1) obtaining a feature vector F expressed as an i -th representative color c_i and as its ratio p_i when N is the number of representative colors in the divided regions of an image, and i is an integer between 1 and N :

$$F = \{ \{c_i, p_i\}, i = 1, \dots, N \};$$

10 (a-2) indexing the image by assigning the representative colors to lattice points of a color space having a lattice structure; and

(a-3) storing indexed results in a database having the form of a separate table.

15 11. The color image processing method according to claim 10, wherein the ratio is a percentage.

12. The color image processing method according to at least one of claim 10 or claim 11, wherein the indexed results include a region
20 identifier expressing the representative colors, their ratio, and serial numbers of an image and a region.

13. The color image processing method according to at least one of claim 10 or claim 11, wherein the image is one region selected from
25 divided regions.

14. The color image processing method according to claim 12, wherein the image is one region selected from divided regions.

30 15. The color image processing method according to at least one of claim 10, claim 11, or claim 14, wherein the color space is a three-dimensional color space.

16. The color image processing method according to claim 12, wherein the color space is a three-dimensional color space.

17. The color image processing method according to claim 13,
5 wherein the color space is a three-dimensional color space.

18. A medium for storing a program performing a color image processing method for indexing an image, comprising the steps of:

(a-1) obtaining a feature vector F expressed as an i -th representative
10 color c_i and as its percentage p_i when N is the number of representative colors in the divided regions of an image, and i is an integer between 1 and N :

$$F = \{ \{c_i, p_i\}, i = 1, \dots, N \};$$

(a-2) indexing the image by assigning the representative colors to
15 lattice points of a 3-D color space divided into a plurality of regions; and

(a-3) storing indexed results in a database having the form of a separate table.

19. The medium according to claim 18, wherein the indexed
20 results include a region identifier expressing the representative colors, their ratio, and serial numbers of an image and a region.

20. A color image searching method for searching an image in the database based on a color feature of a query image, comprising the step
25 of (a) performing a search based on representative colors of a query image and their ratio in the database indexed by assigning the representative colors of a database image to a color space divided into a plurality of regions.

30 21. The color image searching method according to claim 20, wherein the color space is a three-dimensional color space.

22. The color image searching method according to claim 20, wherein the step (a) comprises the steps of:

(a-1) obtaining representative colors of a given query image and their ratio;

5 (a-2) selecting a region corresponding to the representative color obtained in the step (a-1) in a color space divided into a plurality of regions;

(a-3) selecting a data group indexed into the selected region from a database; and

(a-4) identifying matched data in which the difference in the ratio of
10 the representative color of the query image is less than a predetermined threshold value in the selected data group.

23. The color image searching method according to claim 22, wherein the step (a) further comprises the steps of:

15 (a-5) obtaining the sum of the ratio of same regions from the identified data; and

(a-6) determining the region in which the difference between the sum of the obtained ratio and the sum of the ratio to the query image is less than a predetermined threshold value as a searched image.

20

24. The color image searching method according to claim 21, wherein the step (a) comprises the steps of:

(a-1) obtaining representative colors of a given query image and their ratio;

25 (a-2) selecting a region corresponding to the representative color obtained in the step (a-1) in a color space divided into a plurality of regions;

(a-3) selecting a data group indexed into the selected region from a database; and

(a-4) identifying matched data in which the difference in the ratio of
30 the representative color of the query image is less than a predetermined threshold value in the selected data group.

25. The color image searching method according to claim 24, wherein the step (a) further comprises the steps of:

(a-5) obtaining the sum of the ratio of same regions from the identified data; and

5 (a-6) determining the region in which the difference between the sum of the obtained ratio and the sum of the ratio of the query image is less than a predetermined threshold value as a searched image.

26. The color image searching method according to at least one
10 of claim 22 or claim 23, further comprising the step of performing the steps in a color space with respect to neighboring peripheral regions in the case where there are no regions determined as the searched image.

27. The color image searching method according to one of claims
15 20 through 25, wherein the ratio is a percentage.

28. The color image searching method according to claim 26, wherein the ratio is a percentage.

20 29. The color image searching method according to at least one of claims 20 through 25 or claim 28, wherein the query image is one region of the image divided into a plurality of regions, and the searched image is one region of the database image divided into a plurality of regions.

25 30. The color image searching method according to claim 26, wherein the query image is one region of the image divided into a plurality of regions, and the searched image is one region of the database image divided into a plurality of regions.

30 31. The color image searching method according to claim 27, wherein the query image is one region of the image divided into a plurality of regions, and the searched image is one region of the database image

divided into a plurality of regions

32. A color image searching method for searching an image in the database based on a color feature of a query image, comprising the steps
5 of:

(a-1) obtaining representative colors of given query regions and their ratio;

(a-2) selecting a lattice point corresponding to the representative color obtained in the step (a-1) in a three-dimensional color space divided
10 into a plurality of lattices;

(a-3) selecting a data group corresponding to the selected lattice point from the database in which a region identifier expressing representative colors of data images, their ratio, and serial numbers of an image and a region is stored as data; and

15 (a-4) identifying matched data in which the difference in the ratio of the representative color of the query regions is less than a predetermined threshold value in the selected data group.

33. The color image searching method according to claim 32,
20 further comprising the steps of:

(a-5) obtaining the sum of the ratio of same regions from the identified data; and

(a-6) determining the region in which the difference between the sum of the obtained percentage and the sum of the ratio of the query regions is
25 less than a predetermined threshold value as a searched image.

34. The color image searching method according to claim 33, further comprising the step of performing the steps in a color space with respect to neighboring peripheral lattice points in the case where there are
30 no regions determined as the searched image.

35. A medium for storing a program performing a color image

searching method, comprising the steps of:

(a-1) obtaining representative colors of given query regions and their ratio;

(a-2) selecting a lattice point corresponding to the representative
5 color obtained in the step (a-1) in a three-dimensional color space divided into a plurality of lattices;

(a-3) selecting a data group corresponding to the selected lattice
point from the database in which a region identifier expressing
representative colors of data images, their ratio, and serial numbers of an
10 image and a region is stored as data; and

(a-4) identifying matched data in which the difference in the ratio of
the representative color of the query regions is less than a predetermined
threshold value in the selected data group.

15 36. The medium according to claim 34, wherein the color image
searching method further comprises the steps of:

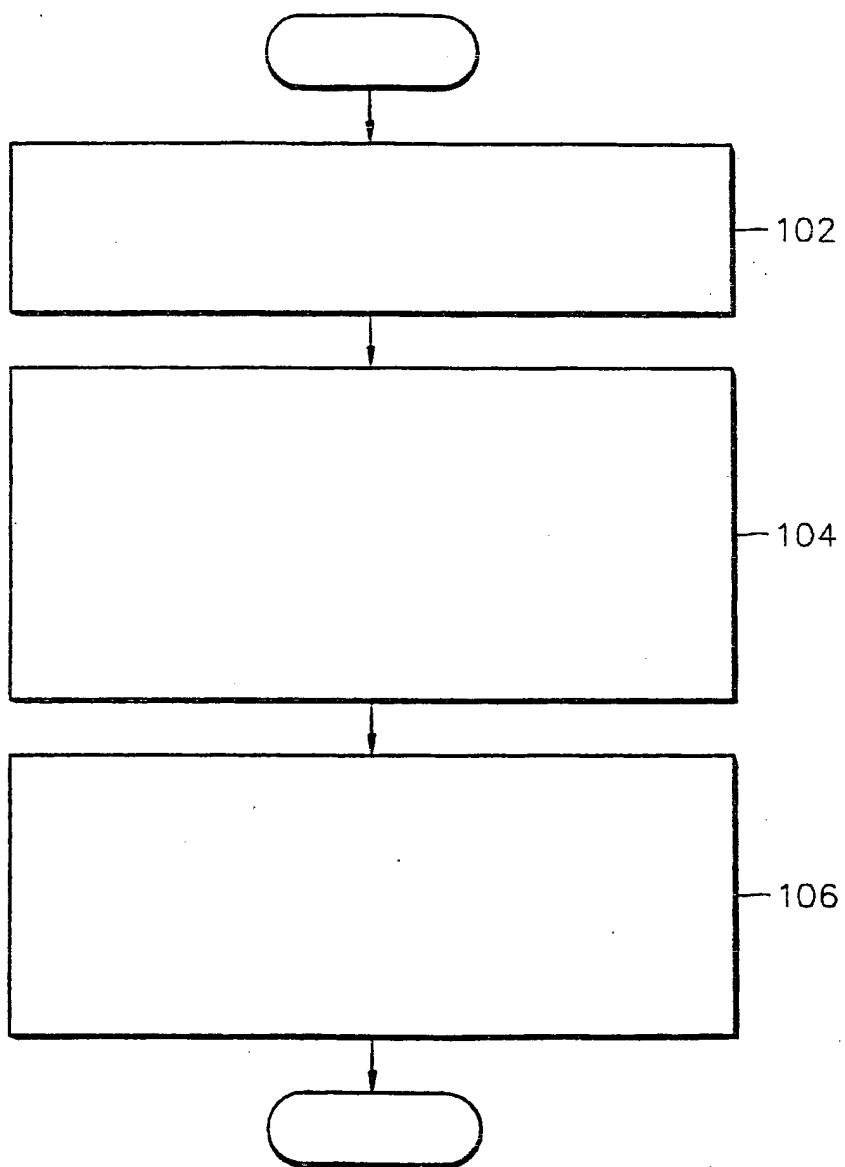
(a-5) obtaining the sum of the ratio of same regions from the
identified data; and

(a-6) determining the region in which the difference between the sum
20 of the obtained percentage and the sum of the ratio of the query regions is
less than a predetermined threshold value as a searched image.

37. The media according to claim 36, wherein the color image
searching method further comprises the step of performing the steps in a
25 color space with respect to neighboring peripheral lattice points in the case
where there are no regions determined as the searched image.

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FIG. 1



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FIG. 2

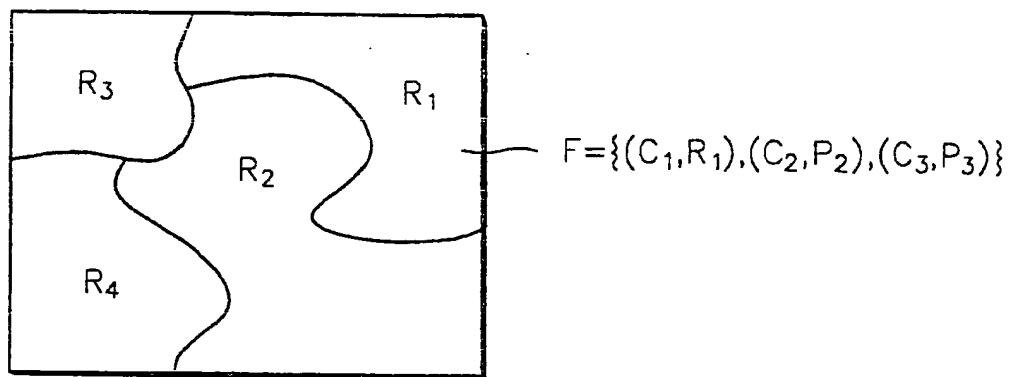


FIG. 3

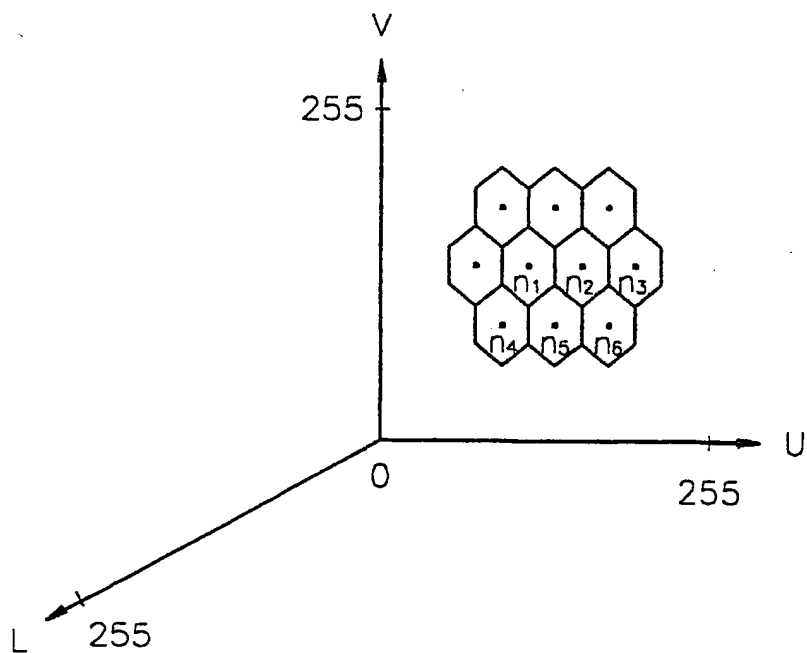
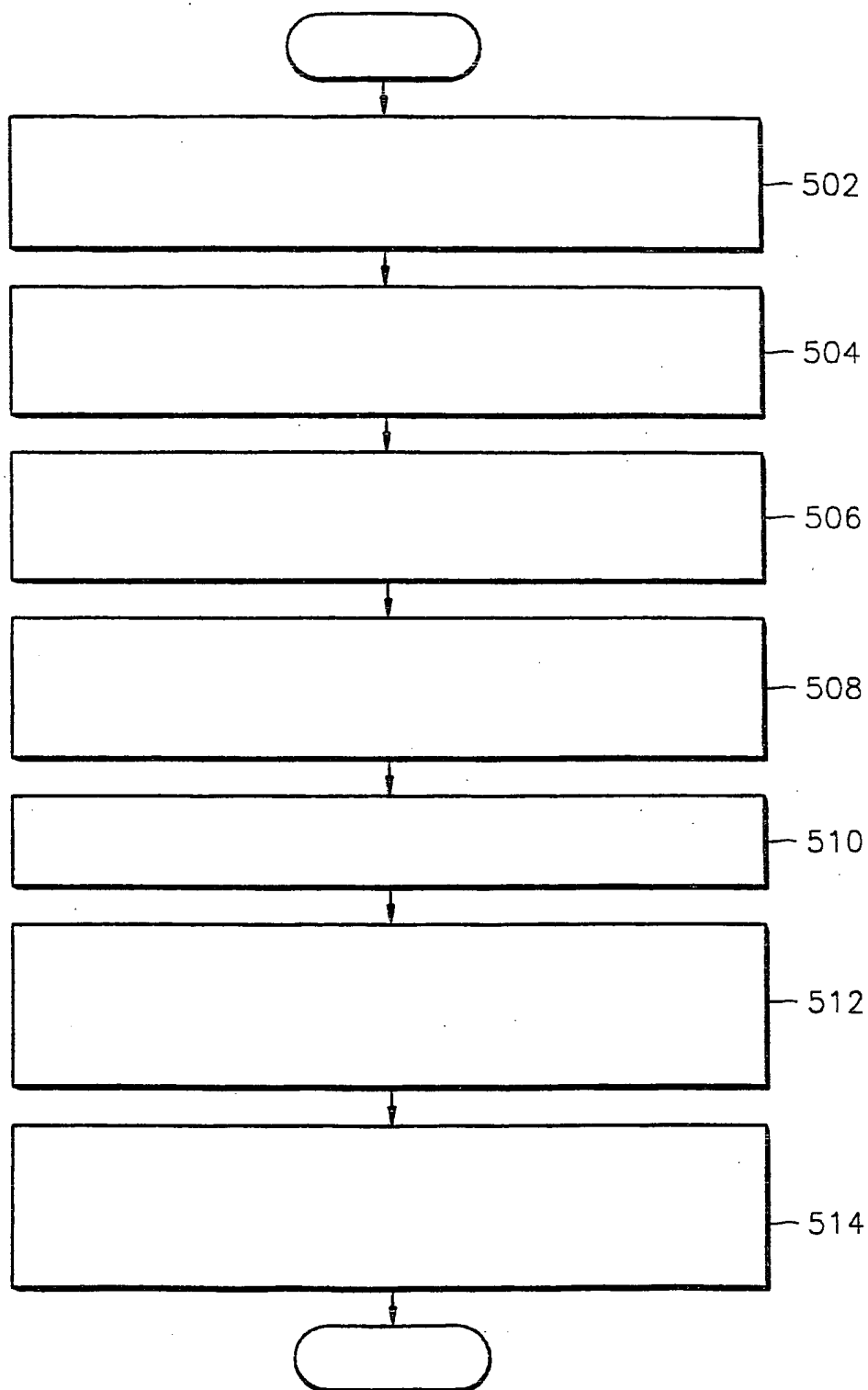


FIG. 4

n_1	n_2	n_3	n_{k-1}	n_k
ID_1, C_1, P_1	.	ID_3, C_3, P_3	.	ID_2, C_2, P_2	.
.		.		.	
.
.

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FIG. 5



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR00/00249**A. CLASSIFICATION OF SUBJECT MATTER .****IPC7 H04N 9/64**

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7 H04N 9/64

Documentation searched other than minimum documentation to the extent that such documents are included in the files searched

Korean patents and applications for inventions since 1975

Korean Utility models and applications for utility models since 1975

Japanese Utility models and applications for inventions since 1975

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

JAPIO, INSPECT "multiple image index"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,325,297 A (Susan w. Bird) 28 JUNE 1994 see the whole document	1-3, 5-9
A	JP 9-298747 (D&I systems CO.) 18 NOVEMBER 1997 see the whole document	1-37

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

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Date of the actual completion of the international search

18 MAY 2000 (18.05.2000)

Date of mailing of the international search report

24 MAY 2000 (24.05.2000)

Name and mailing address of the ISA/KR

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/KR00/00249

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5,325,297 A	28. 7. 94	NONE	
JP 9-298747 A	18. 11. 97	NONE	